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J2R Scientific

http://www.J2RScientific.com

How to Build a J2
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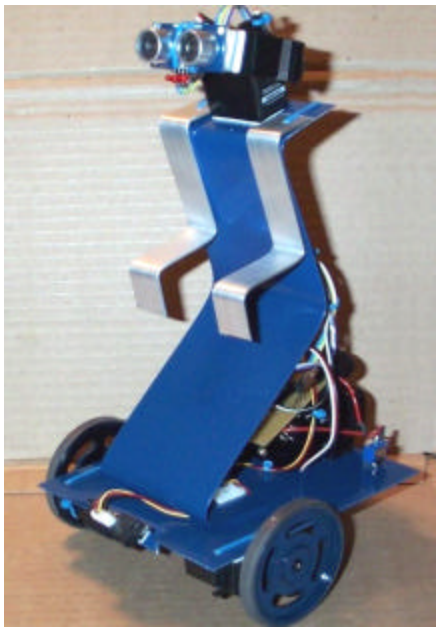


Figure 1.

The J2 robot (**Figure 1**.) from J2R Scientific is a compete robot ready to run out of the box. Its design is part of the REOP (Robotics Education and Out Reach program of The Robotics Club of Yahoo or www.trcy.org

The J2 has been a fun project. My original idea was to create a security robot after the 9-11 attacks. After dedicated thought into all aspects of what a security robot would require, I decided it was better to start small so I could more easily model the behaviors and systems I would need for a security robot. This led me to create the J2 robot, which does bare a passing resemblance to a somewhat famous movie robot of the mid 80's.

The J2 allowed me to experiment with Subsumption programming and the new PING sonar range modules from Parallax, inc.

In the creation process of J2 I decided I really needed to focus on what I wanted from my robot and what I thought other people would want to see. I decided my robot needed to look interesting; be easy to add components to; easy to remove components from; and be easy to use.

With these guidelines in mind I chose the Basic Stamp II as the micro-controller. I decided on a standard sensor compliment of Sonar for navigation, IR for close up or edge detection, CdS photo cell for light level and a multi-input port for multiple switch inputs from either a keypad or several bump sensors. I decided on two continuation rotation servos for drive motors and a servo controlled neck for the sonar to look up and down. The J2 did not need to turn the sonar side to side (I'll explain why). I wanted a speaker for tone generation, to give J2 a voice.

I also wanted to experiment with the new Text-to-Speech Emimic board from Parallax, inc. And have the ability to add more subsystems and components easily.

Once I knew what I needed to focus on I could design the board. **Figure 2** shows the J2 schematic and **figure 3** shows the PCB artwork as laid out using free software from www.expresspcb.com Prices for boards are very reasonable. One note of caution, double check the hole spacing and size before you place an order. With all the options it's easy to choose a wrong size or settings. It's a great program and service and I highly recommend them for anyone.

Figure 2.

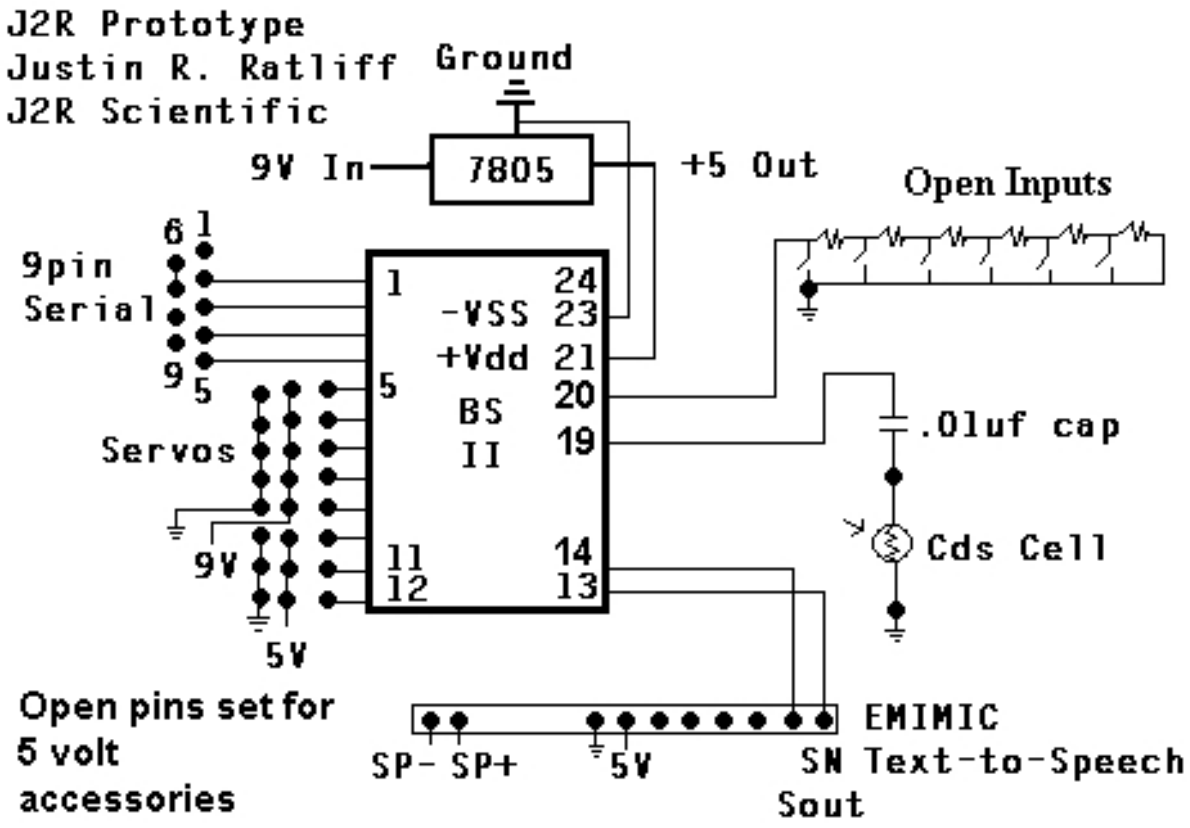
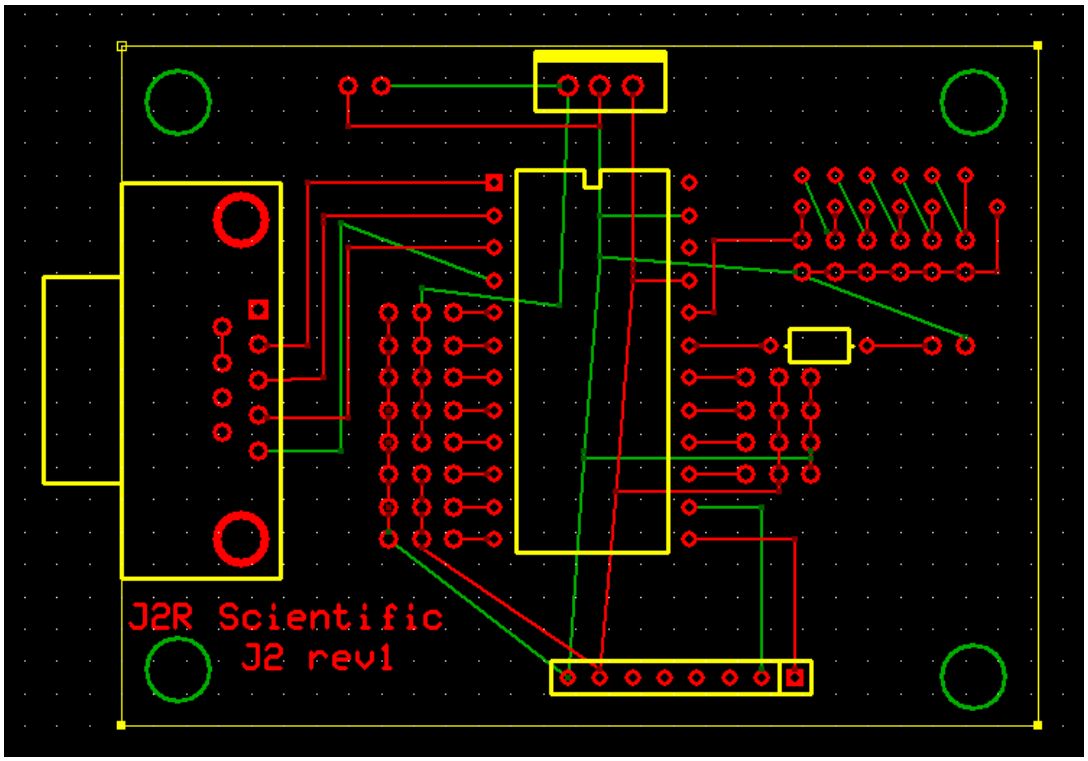


Figure 3.



Below is the listing for the standard i/o assignments on the J2:

Neck = i/o 2
Right Servo = i/o 1
Left Servo = i/o 3
GP2D12 IR = i/o 6
PING Sonar = i/o 7
Speaker = i/o 8
Text-to-Speech (if installed) = i/o 8 and 9
LED Mouth Option = i/o 10
CdS Option = i/o 14
Multi Input Option = i/o 15

Parts List:

Qty:	Parts:	Source:
1	Basic Stamp II	Parallax.com
2	Continuous Rotation Servos	Parallax.com
1	Standard Servo	Parallax.com
1	Emimic Text-to-Speech Module	Parallax.com
1	PING Sonar Module	Parallax.com
1	J2 PCB	J2R Scientific
1	J2 Body	J2R Scientific
1	9pin DSUB female connector	Digikey.com

1	24pin DIP Socket	Jameco.com
1	8pin SIP Socket	Jameco.com
2	Servo Wheels	Acroname.com
1	Sharp GP2D12 IR Module	Acroname.com
1	6 AA Battery Pack	
1	CdS Photo Cell	
1	Power Switch	
1	5V Regulator	
1	Caster Wheels	

Misc: wire ties, double sided tape, wire, heat shrink tubing, misc. connectors

The production J2 is built from stainless steel. The prototype body was built from Plexiglas. I cut the Plexiglas to size and heated it with a heat gun to bend it into shape. For a beginner I believe Plexiglas is cheaper, easier to work with and more forgiving than metal. It's also very light weight and fairly strong. **Figure 4** shows the prototype plastic J2 layout with larger foam wheels.

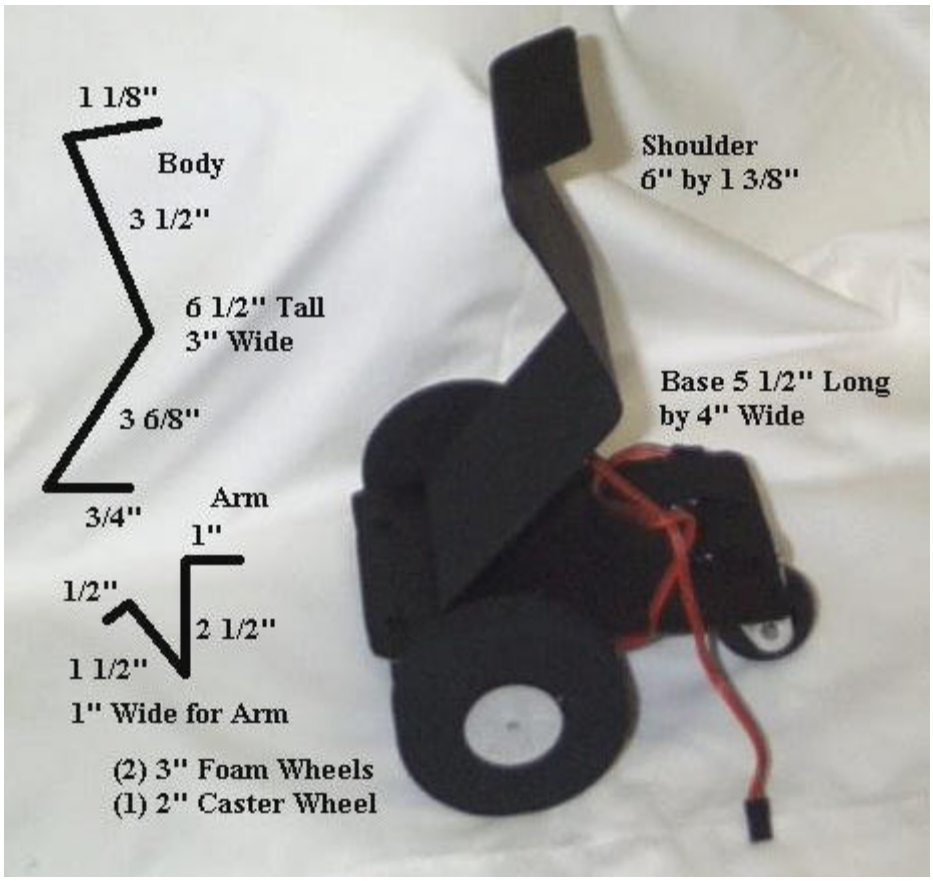


Figure 4.

A heat gun is sort of like an industrial hair dryer and you can pick one up at your local hardware store for around $30. When heating plastic to bend it you want to heat the surface of the plastic where you'll place a bend and apply heat evenly. The plastic will need to get fairly hot, but if you see the surface structure start to change texture you know you've applied too much heat! With clear Plexiglas you'll see the surface start to granulize if it gets too hot.

If you choose to paint the Plexiglas I recommend you use a plastic primer spray paint from your hardware store to cover the Plexiglas before you apply your final paint color. A final layer of clear coat will add protection to your robot's paint and body.

With the J2 programs based on Subsumption behavioral subroutines it makes it easy to add new behaviors and adds at times at least the appearance of intelligence. To program the J2 you'll need to download the Basic Stamp editor either the DOS or Window's version from www.parallax.com. Below is the J2SubSumExplore program. You can download the latest J2 code from www.j2rscientific.com See **Figure 6** for the standard J2 Explore program.

Lesson Learned: It is always better to start small. Master all that you can, seek perfection from every part of your small robot before you move onto larger projects. Always apply the "keep it simple" approach to your design. Lay out your robot designs on paper with as much detail as possible in the hardware and programmed actions of the robot. Imagine your robot going through the actions of your program with the hardware you have drawn out. Many mistakes and limitations can be discovered before you begin building your robot if you invest the time to think through your design.

For instance, the J2 does not have a servo to turn the sonar side to side but it can look up and down, why is that? On such a robot (in my opinion) it would be wasteful to include a servo to rotate the head side to side when the robot can turn its wheels to look side to side. Also if the robot sees something of interest to the side, it will already be ready to drive toward what it sees. If a servo rotated the neck to the side, the robot would need to turn its body to match what the head saw.

This one detail of removing one servo from the head saves on power consumption, code space, and weight and makes the robot more efficient.

Figure 6. Robot Code

```
' {$STAMP BS2}
'J2SubSumExplore.BS2
'J2R Scientific
'12-12-2005
'J2 will explore about the world using subsumption based
'behavioral based intelligence.

'Generic values
tmp    VAR  Word            ' tmp var, many routines
ltmp   VAR  tmp.BYTE0
htmp   VAR  tmp.BYTE1
seed   VAR  Word            'random number seed
val05  VAR  Byte
time   VAR  Word
i      VAR  Byte             'loop counter
```

```
a     VAR  Byte
PING   CON   7          'PING sonar port
LEFT   CON   3          'left wheel port
RIGHT  CON   1          'right wheel port
NECK   CON   2          'neck servo port
SPKR   CON   8          'speaker port
LED    CON   10         'LED mouth, this is not standard on all J2's

'These are for the servo routines
SACT  CON  5                'times through act routine
drive  VAR  Word            'wheel command combo
ldrive  VAR  drive.BYTE1    'left wheel command
rdrive   VAR  drive.BYTE0   'right wheel command
aDur    VAR     Nib          'duration of pulsout

'normal list follows
rv  CON  $6432      'forward
fd  CON  $3264      'reverse
st  CON  $4d4d      'stop
tr  CON  $324d      'turn right
tl  CON  $4d64      'turn left
rl  CON  $6464      'rotate right
rr  CON  $3232     'rotate left
bl  CON  $644d      'backup turning left

'wander values
wDir  VAR  Word      'wander value
wDur  VAR  Byte      'wander duration

'avoid states and vars
avDir  VAR  Word     'direction
avDur  VAR  Nib      'duration

'bumper vars and constants
bumper  VAR  IN6    'bumper io pin
bstate  VAR  Nib     'bumper FSM state
bDir  VAR  Word      'bumper direction holder
bDur  VAR  Byte      'duration in that direction

'set up for running
wDur = 0       'clear wander duration
aDur = 0       'clear act loop counter
bDur = 1       'clear bumper duration, may need to change back to 0
bstate = 0
drive = st      'stop servo motors - not really needed
LOW LED

main:                   'subsumption architecture
  GOSUB wander      'random wander instinct is lowest priority
  GOSUB avoid       'avoid running into stuff
```

```
  GOSUB bumpck      'don't stay bumped into it = highest priority
  GOSUB act         'acts on highest priority movement needed
                    ' i.e. last to set direction
  GOTO main

wander:             'randomly wander around
  IF wDur > 0 THEN wDone1
  RANDOM seed       'random direction
  i = seed & %111   'mask off for 0-7 only
  LOOKUP i,[fd,tl,fd,fd,fd,fd,tr,fd],wDir 'chose direction
  seed = seed + i
  wDur = (seed & %111111) + 20  'mask for 64 choices of duration
wDone1:
  wDur = wDur - 1   'decrement wander counter
  drive = wDir      'get direction
  PULSOUT NECK, 900
  LOW LED
  RETURN            'completed

act:                'moves servo motors
  IF aDur > 0 THEN aDec     'already doing one, got here
  aDur = SACT               '# of main loops between pulseouts +1
  PULSOUT LEFT,ldrive * 10
  PULSOUT RIGHT,rdrive * 10
aDec:  aDur = aDur - 1      'decrement act loop cntr
  RETURN




avoid:
 PULSOUT 7, 5
  PULSIN 7, 1, time
  time = time ** 2251
    IF time > 0062 THEN avdone

  avfront:
  HIGH LED
  avDir = rl                'rotate away
       avDur = 15
       drive = rl
       GOTO avdone

avdone:
RETURN

bumpck:
  IF bumper = 0 THEN bmpnow
  IF bDur > 0 THEN bmpact
```

```
  BRANCH bstate,[bDone1,bbup]

breset:             'end state 2, now reset
  bstate = 0        'state machine to idle
  RETURN

bbup:               'end state 1, now
  bDir = rl         'rotate left away
  bDur = 65         'sets time limit
  bstate = 2        'next state
  GOTO bdrive

bmpnow:             'being bumped now
  bDir = rv         'set backup while bumped and
  bDur = 61         'for a while (+1) after not being bumped
  bstate = 1        'start state machine

bmpact:             'bump mode active
  bDur = bDur - 1   'decrement bump timer

bdrive:
  drive = bDir      'set drive direction to bump

bDone1:             'no bump
  RETURN

END
```